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PERMIAN ELEMENTS IN THE FOSSIL FLORA OF THE APPALACHIAN PROVINCE. I.

TAENIOPTERIS

BY

WILLIAM C. DARRAH

INTRODUCTION

THE LATE DOCTOR DAVID WHITE studied the floras of supposed Permian age in Pennsylvania and West Virginia for more than thirty years. His observations¹ essentially substantiated those of Fontaine and I. C. White² who published the only comprehensive survey of the flora of the Dunkard Group. This fossil flora contains a complex intermingling of Carboniferous, Permian and "Triassic" plants. More precisely the last group are plants of "Mesozoic implication." Most investigators have followed the conclusions of David White and of Fontaine and White, and have regarded the Dunkard rocks to be of Permian age. That there is a true Permian flora in the Dunkard is incontestably demonstrated by the presence of Callipteris. However, this important indicator makes its appearance at the base of the Greene or Upper Dunkard. In a strict sense the Permian division-

¹ Bull. Geol. Soc. Am. vol. 14. pp. 538-540. 1904

² Permian Flora; Harrisburg 1883

line begins at this appearance.³

The Washington or Lower Dunkard is considered to be Pennsylvanian or Upper Carboniferous and the fossil flora of the Washington admits no other correlation.⁴ The most significant plant forms discovered in the Dunkard include *Taeniopteris*, *Baiera*, *Callipteris* and *Sapor-tea*. No specimens of these forms were known to exist because Fontaine's collections were destroyed by fire. There is some reason to believe these may be rediscovered in old collections. In recent collections I have been able to find not only *Taeniopteris*, *Baiera* and *Callipteris*, but also *Walchia* and *Lescuropteris*. Of these genera, *Callipteris* alone is considered to be a certain Permian indicator.

I propose to present several short notices to establish the status of these plants in the fossil floras of the Appalachian province. These "cosmopolitan" forms (except *Lescuropteris*) are among the most important late Paleozoic plants known to paleobotanists.

TAENIOPTERIS

*Taeniopteris*⁵ is a frond-genus including diverse plants. Some of the "species" are ferns of Marattiaceous affinities, although the majority are cycadophytes. In the absence of convincing evidence based upon fructifications, it is unwarranted to sort out the forms. It is usually assumed that the Paleozoic species are ferns or seed-ferns, and the Mesozoic species are Bennettitalean. The name *Macrotaeniopteris* has been used to designate the Mesozoic forms, but since a number are of diminutive size, considerable objection has been raised against

³ Darrah 1934 Proc. Geol. Soc. Am. (1933) p. 451

⁴ Darrah 1935 Summaries of Papers for Carb. Congress pp. 1-8

⁵ See Seward 1910. Foss Pls. vol. 2. pp. 485-494

such usage. The generic concept of *Taeniopteris* was formulated by Brongniart⁶ and the type of the genus is *Taeniopteris vittata* Brongniart. The description of a number of species since the work of Brongniart has extended the concept to include petiolate leaves and bipinnate fronds. The propriety of this inclusive interpretation is open to criticism.

A score of Paleozoic *Taeniopteris* have been described. The so-called "species" are poorly defined, although five specific alliances are easily recognized. All of them are characteristic of the Permian, despite the fact that a number of pre-Permian occurrences have been reported. Together they possess a broad northern-hemisphere distribution usually considered as "cosmopolitan." *Taeniopteris*, in its broadest sense ranges from the Upper Carboniferous to Lower Cretaceous (or Neocomian).

The specimen reported in this paper was found in the roof-shales of the Uniontown Coal, Monongahela Group (Upper Carboniferous) at Monongahela City, Fayette County, Pennsylvania. The specimen is number 12455 in the Paleobotanical Collection of the Botanical Museum of Harvard University. Collected by Darrah, November 1933. Two impressions of a *Taeniopteris* are preserved in the dark gray, fine-grained shale. They are of a single species which conforms to *Taeniopteris jejunata* Grand' Eury, and present no character upon which a specific separation may be based. Grand' Eury's plant is relatively abundant in the Stephanian and Rotliegende of France, Germany, Spain and Czechoslovakia. The specimen also bears a relation to *Taeniopteris lescuriana* Fontaine & I. C. White. This form,⁷ together with a second,⁸ *T. newberriana* was described from material col-

⁶ 1828 Prodr. p. 61; Hist. veg. foss. I. p. 262

⁷ Perm. Flora. p. 91. pl. 34. fig. 9, 9a

⁸ Ibid. p. 91. pl. 34. fig. 1-8

lected from the Waynesburg Coal, Washington Group (Lower Dunkard) at Cassville, West Virginia.

An unfortunate confusion has been caused in Europe as a result of a citation by Potonie⁹ who referred "*T. newberryana*" ex parte to *T. jejunata* and cited pl. 34 fig. 9, 9a in the synonymy. This is a misstatement as Selards recognized in 1900,¹⁰ because the figures refer to *T. lescuriana* not *T. newberriana*. *Taeniopteris newberriana* belongs to the group of *T. coriacea* Goeppert—a relationship which Fontaine and White recognized. They suggested that *T. lescuriana* was a member of the *T. multinervis* group. This reference is more trivial than is apparent, because *T. jejunata* differs from *T. multinervis* Weiss chiefly in possessing bipinnate fronds.

It is not certain that the Monongahela specimens are identical with *T. lescuriana*. No specimens of this species are known for comparison and the published figures are almost of no value. Consequently the name *T. lescuriana* must be retained until the type can be found and redescribed.

The fragments are sufficient for diagnosis and may be referred without hesitation to *T. jejunata*.

Taeniopteris jejunata Grand' Eury

1877 Flore carb. du dép. de la Loire p. 121.

1885 Zeiller: Bull. Soc. Geol. Fr. 3. Ser. 13: 137
pl. 9 fig. 2.

1888 Zeiller: Fl. foss. Commentry vol. 1 p. 280
pl. 22 fig. 7-9.

1893 Potonie: Fl. d. Rotl. v. Thuringen p. 145 pl.
17 fig. 3.

1906 Zeiller: Fl. foss. Blanzky et Creusot p. 111 pl.
33 fig. 1, 2.

⁹ Die Flora d. Rotl. v. Thuringen p. 145

¹⁰ Kans. Univ. Quart. 1901. vol. 10. p. 5

There are few good figures of this species, therefore I have indicated those generally accessible. The two specimens from Pennsylvania are slightly larger than those from Europe:

A. length = 38 mm.; max. width = 18 mm.; min. width = 15 mm.

B. length = 29 mm.; max. width = 14 mm.; min. width = 10 mm.

Neither is complete so it is not known if the leaf-base was petiolate or decurrent. The mid-rib is slender, the secondary veins depart at an angle of 45 degrees and always fork twice near the departure from the mid-rib. The branches of the secondary veins frequently fork again near the entire margin. These characters are similar to those usually found in European specimens, but are in certain respects unlike those of *T. lescuriana* which is much larger (10 cm.) and has a more slender mid-rib. In *T. lescuriana* the branches of the nerves rarely fork near the margin.

Potonie¹¹ gives the distribution of *T. jejuna* as Floras VI to VIII or in other words, from the Upper Ottweiler (=Stephanian) to the Lower Rotliegende. The same range is given by Gothan¹² who states that it is essentially Permian although it appears in the Uppermost Carboniferous. Bertrand¹³ lists *T. jejuna* among the characteristic plants of the Saint-Etienne flora (Stephanian) of France. No undoubted records of this or of any other Taeniopteris occur earlier than the Stephanian stage of the Carboniferous. Lesquereux^{14,15} has described two Pottsville (= Westphalian) "Taeniopterids." The

¹¹ 1896 Die floristische Glied. d. deutsch. Carb. u. Perm. p. 31

¹² 1923 Karb. u. Perm. Pflanzen p. 76

¹³ 1928 Cong. Strat. Carb. Heerlen. 1927. p. 97

¹⁴ Coal Flora. vol. 1. p. 153. pl. 25. fig. 7

¹⁵ Ibid. vol. 3. p. 743. pl. 94. fig. 8

first, *T. smithii* was transmitted to him without label, but it is supposed to have come from the Pottsville of Alabama. The other, *T. truncata* was found in the Pottsville ("sub-conglomerate") of Campbell's Ledge, Pittston, Pennsylvania. Lesquereux questioned the reference of this species to *Taeniopteris*. Both of these plants belong to *Megalopteris* a genus characteristic of the Pottsville.

David White¹⁶ has also described a species, *Taeniopteris* ? *missouriensis*, which is from the Lowest Allegheny or Upper Pottsville. There is a superficial resemblance to *T. jejuna* but a close inspection shows that its affinities are with the Pottsville *Alethopterids* such as *A. maxima* Andrews and *A. macrophylla* Newberry. In the later paper White questioned the genus and remarked that "perhaps it belongs more properly in *Alethopteris*." It is within the range of possibility that such *Alethopterids*, *Megalopterids* and the early bipinnate *Taeniopterids* have much in common. White's plant should be designated *Alethopteris missouriensis*.

Alethopteris, so far as known possesses medullosan stems and is thus pteridospermic. The botanical relations of the Paleozoic *Taeniopterids* are most uncertain. The term "pteridophyll" is usually applied to fern-like foliage of unknown attachment. The weight of evidence seems to indicate that they are marattiaceous ferns, although Sterzel¹⁷ observed *Taeniopteris abnormis* Gutbier from the Rotliegende of Chemnitz with a species of *Medullosa*. If this attachment can be substantiated, a portion of the *Taeniopteris* group is pteridospermic. Zeiller¹⁸ was inclined to agree with Sterzel although he did not examine the material. Both I.C. White and Sellards are reputed

¹⁶ Bull. Geol. Soc. Am. vol. 4. p. 119. pl. 1. 1893.

U. S. Geological Surv. Mon. 37. p. 140. pl. 40. fig. 1-7. 1899

¹⁷ Beitrage zur Kennt. d. Medulloseae p. 118. 1896

¹⁸ Fl. foss. Blanz y p. 111. 1906

to have found fructifications on American Taeniopterids, but the evidence is inadequate. Certainly there is no basis for assuming that the Paleozoic members are cycadophytes in a restricted sense.

As a matter of permanent record it may be well to present a compilation of all the American occurrences and place them with their related species.

The most comprehensive account of Paleozoic Taeniopterids is that given by Professor T. G. Halle in his magnificent memoir on the Shansi flora.¹⁹ In this work he describes eight species, six of which are new. Halle adopted a strict delimitation of species. Sellards²⁰ has given a full account of the Kansas Taeniopterids. More recently David White²¹ and Elias²² have added to our knowledge concerning their distribution in southwestern United States. White has also recorded a number of specimens from the Hermit Flora ("Upper Permian") of Grand Canyon, Arizona.²³ These are attributed to three species, one of which was new: *Taeniopteris* aff. *T. eckhardti* Kurtze, *T. angelica* D. White (p. 93) and *T. coriacea* Goeppert. The first of these does not belong to Kurtze's plant.

PALEOZOIC TAENIOPTERIDS

Taeniopteris jejuna Grand' Eury

1877 Flore Carb. Loire p. 121.

Common in Europe. Reported now from Pennsylvania.

¹⁹ Paleont. Sinica, Ser. A. vol. 2, Fasc. 1, 1927

²⁰ Kans. Univ. Quart. 1901. vol. 10. pp. 1-12. figs. 1-4

²¹ Proc. U. S. Nat. Mus. 1912. vol. 41. pp. 505-508

²² XI Int. Geol. Congr. Abstracts 1933. pp. 69, 70

²³ Carn. Inst. Wash. Publ. 405. 1929. pp. 92-95

Related species:

Taeniopteris carnoti Renault & Zeiller

1888 Etudes terr. houill. Commentry vol. 1 p.
282 pl. 22 fig. 10.

Stephanian of France

Taeniopteris lescuriana Fontaine & White

1883 Perm. Flora p. 91, pl. 34. fig. 9, 9a.

Stephanian (Washington) of West Virginia

Taeniopteris plauensis Sterzel

This species probably belongs here.

***Taeniopteris coriacea* Goepfert**

1864 Foss. Fl. Perm. Form. p. 130. pl. 8. fig. 4; pl.
9. fig. 2.

Common in Europe, also in Texas, Kansas and Oklahoma.

Related species:

Taeniopteris newberriana Fontaine & White

1883 Perm. Flora p. 91. pl. 34. figs. 1-8.

West Virginia and Kansas.

Taeniopteris tingii Halle

1927, in Pal. Sinica. v. 2. p. 158. pl. 42. figs. 1-8.

Permo-carboniferous of China.

***Taeniopteris multinervis* Weiss**

1869 Foss. Fl. Jung. Steink. u. Rotl. p. 98. pl. 6.
fig. 13.

Abundant in Europe, Asia and southwestern United States, it is not known from the Appalachian province.

***Taeniopteris abnormis* Gutbier**

1835 Vers. Zwick. Schwarzkohl p. 73.

1849 Vers. d. Zeckst. u. Rothl. p. 17. pl. 7. figs. 1, 2.

Rather rare in Europe; occurs in Texas and Oklahoma.

Related species:

Taeniopteris shansiensis Halle

1927 in Pal. Sinica. v. 2. p. 153. pl. 40. figs. 1-4.

Taeniopteris nystroemii Halle

1927 in Pal. Sinica. v. 2. p. 148. pl. 39.

Taeniopteris latecostata Halle

1927 in Pal. Sinica. v. 2. p. 145. pl. 38. figs. 1-6.

Taeniopteris fallax Goepfert

1864 Foss. Fl. Perm. Form. p. 130. pl. 9. fig. 3.

Rare in Europe

Related species:

Taeniopteris densissima Halle

1927 in Pal. Sinica. v. 2. p. 156. pl. 41. figs. 5-7.

Halle considers "*Taeniopteris*" *smithii* Lesquereux to be a relative of *T. fallax*. It is really a *Megalopteris*.

Several other satisfactory species are known and these are cited for comparison. None of them are known to have close American affiliates.

Taeniopteris schenki Sterzel in Neues Jahrb. Min. 47 (1876) 382. pl. 5. fig. 6, 6a.

Taeniopteris Zeilleri P. Bertrand in Ann. Soc. geol. Nord, 39 (1910) 353. pl. 4. fig. 1-5.

Taeniopteris norini Halle in Pal. Sinica 2 (1927) 157. pl. 41. fig. 8, 9.

Taeniopteris serrulata Halle in Pal. Sinica 2 (1927) 160. pl. 42. fig. 13-18.

Taeniopteris (?) *serrata* Halle in Pal. Sinica 2 (1927) 161. pl. 42. fig. 1-12.

I have intentionally disregarded several records of *Taeniopteris* based upon fragmentary specimens which

have not received specific designation. All of these indeterminate fragments are from Kansas and Texas and probably belong to well-known species.

This genus obviously possessed an extensive geographic distribution during Stephanian and Permian times. Its value as an "index" genus has been recognized in Europe. Halle considered it to be significant in China, and Elias (l. c.) called attention to its position in the Kansas succession.

The plants associated with *Taeniopteris jejunata* in the Monongahela series of western Pennsylvania are:

<i>Pecopteris arborescens</i>	<i>Neuropteris cordata</i>
<i>Pecopteris feminaeformis</i>	<i>Neuropteris rogersi</i>
<i>Pecopteris unita</i>	<i>Neuropteris grangeri</i>
<i>Pecopteris polymorpha</i>	<i>Neuropteris</i> sp.
<i>Pecopteris bredovi</i>	(aff. <i>N. neuropteroides</i>)
<i>Pecopteris daubreei</i>	<i>Odontopteris reichi</i>
<i>Callipteridium gigas</i>	<i>Odontopteris genuina</i>
<i>Diplotmema ribeyroni</i>	<i>Odontopteris</i> sp. nov.
(<i>Mariopteris cordato-ovata</i>	<i>Sigillaria brardi</i>
Lesqx., non Weiss)	<i>Asterophyllites equisetiformis</i>
<i>Zeilleria</i> sp. nov.	<i>Sphenophyllum oblongifolium</i>
<i>Sphenopteris minutisecta</i>	<i>Sphenophyllum tenuifolium</i>
<i>Alethopteris grandini</i>	<i>Poacordaites</i> sp.
<i>Lescuropteris moorii</i>	<i>Walchia</i> sp (aff. <i>W. piniformis</i>)
<i>Taeniopteris jejunata</i>	

This association appears in the Upper Conemaugh Series (Clarksburg member) and continues with slight modification to the top of the Washington Series. *Lescuropteris* is abundant in the lower portion of the sequence and *Odontopteris* is most abundant in the middle.

The affinities of this flora are with those of St. Etienne, Commentry, Gard, Blanzky and Creusot. These localities are "type" Stephanian, and the species cited belong to the middle and upper Stephanian.

Professor Paul Bertrand has generously given his opinions and advice on my specimens. He has verified the identifications of *Taeniopteris jejunata*, *Odontopteris genuina*, *Pecopteris daubreei* and *Odontopteris reichi*.

The plant recorded here as *Diploptmema ribeyroni* Zeiller²⁴ is a common form which attains its maximum of abundance in the Lower Monongahela. The American specimens have been erroneously identified with *Pseudopecopteris cordato-ovata* Weiss. Lesquereux based the reference of a number of specimens to the species defined by Weiss on material from Pottsville. Due to an error in the *Coal Flora* the locality was considered to be Wilkes Barre instead of Pottsville. In the earlier years of investigation Lesquereux did not distinguish between *Pseudopecopteris sillimannii* and *Pseudopecopteris cordato-ovata*. Consequently his tray labels read "Wilkes Barre and Pottsville." The original manuscript catalogue gives the locality of the specimen figured on plate 37, figure 4 of the *Coal Flora* as Salem Coal, Pottsville, Pennsylvania.

David White described *Mariopteris occidentalis*²⁵ from the McAlester Coal Field and in comparing the plant figured by Lesquereux, cited it as *Mariopteris cordato-ovata* Weiss, Lesqx. The two species are distinct, *Mariopteris occidentalis* White is of Cherokee (= Allegheny) age.

The true nature of these specimens was recognized by Zeiller who included *Pseudopecopteris cordato-ovata* Lesquereux, non Weiss, in the synonymy of *Diploptmema ribeyroni*. He cited figure 4, plate 37 of Lesquereux. This figure is rather poor. The basal heteromorphy of the pinnules, a character which at once distinguishes it

²⁴ Fl. foss. Autun et Epinac p. 37. pl. 9A. fig. 1. See also Fl. foss. Commentry p. 91. pl. 4. figs. 3-5.

²⁵ U. S. G. S. 19th. Ann. Rept. 1899. pp. 480-483.

from *Mariopteris cordato-ovata* Weiss,²⁶ is much more pronounced than is indicated by the figure. American investigators have disregarded Zeiller's citation because the location of Lesquereux's specimen was unknown. It has been found in the Lesquereux collection at the Botanical Museum of Harvard University (number 6331). It conforms in every particular with Zeiller's figures and descriptions. *Diplotmema ribeyroni* has been found at Pottsville, Port Carbon, Rennerdale, Monongahela and Waynesburg, all in Pennsylvania and at Providence, Rhode Island.

The late Pennsylvanian rocks contain many of such "Permian" indicators. Their presence carries far more significance than the typical Coal measures plants among which they are submerged.

The occurrence of *Taeniopteris* in the Appalachian province is a fortunate event because its precise distribution in the Pennsylvanian Series can be determined. Fontaine and White found two species in the Washington or Lower Dunkard. Now the Monongahela Group beneath is also known to contain *Taeniopteris jejuna*. Consequently it would be difficult to reconcile the opinion recently expressed by Jongmans and Gothan²⁷ that no equivalents of the European Stephanian occur in eastern North America. Both the Washington and Monongahela Groups are Stephanian and characterized by a few "Permian" types. *Taeniopteris* is one of the most constant and widespread of these types.

²⁶ Foss. Fl. p. 28. pl. 1. fig. 1.

²⁷ 1934 Jaarverslag over 1933 Geol. Bur. Nederl. pp. 17-44